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VERIFICATION OF TRANSLATION

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declare that I am well acquainted with both the French and English languages, and that the attached is an accurate translation, to the best of my knowledge and ability, of the French language specification filed on June 9, 2006.

I further declare that all statements made herein of my knowledge are true and that all statements made on information and belief are believed to be true; and, further, that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the above-captioned application or any trademark issued thereon.

Signature ______________________ Date August 23, 2006

AUDREY MESCHAIN-CASTEL

METHOD FOR MANUFACTURING A GLIDING BOARD AND BOARD THUS OBTAINED

The invention relates to the field of methods for manufacturing gliding boards comprising a foam core. It will especially find applications in the fields of skis, snowboards, water skis, wakeboards, boards for kitesurfing, surfing, and windsurfing.

The invention is first described in the context of its application to a kitesurfing board, that is, a board adapted to support the user on water while being pulled by a kite, on the one hand, and to the field of skis, on the other hand.

Boards for kitesurfing have dimensions ranging between 120 and 170 cm lengthwise and 30 and 60 cm widthwise, while being only a few centimeters thick.

A common method for manufacturing such boards is derived from the conventional method for manufacturing surfboards. A foam cake, made by molding, is machined (manually or by means of a digitally controlled machine) to obtain the shapes of the final core; the latter core is then covered with a skin. This skin is generally comprised of reinforcement layers (such as fiber textile) embedded in resin. One thus obtains a relatively light and rigid composite structure. Naturally, boards with very different characteristics are obtained as a function of the type of materials making up the skins, which can go from a mere sheet of thermoformed ABS resin to a composite sandwich complex, as well as glass, carbon, Kevlar fiber composites embedded in polyester or epoxy resins.

With such a manufacturing method, the core therefore requires lengthy and complex shaping operations, as it often involves producing a three-dimensional final shape comprising essentially curved surfaces. Oftentimes, this fabricating requires a lengthy manual finishing operation of the core by planing and sanding.

It has already been proposed to mold these cores directly to the desired shape, either by injection into a mold, or by expansion in the mold. In this case,

the final core is obtained in a simpler and often faster manner. However, the molding speed is relative insofar as the foam needs time to spread out inside the mold and to crosslink. Such a cycle generally requires at least ten minutes or so. During that time, the mold is made unavailable, so that if one wishes to manufacture a large number of cores, it will be necessary to obtain numerous identical molds, which, in addition, requires a large area of the production unit.

Furthermore, in the two previously described manufacturing methods, one tends to obtain a core in which the foam has a substantially uniform density throughout the core. However, this is not necessarily an optimal solution.

Indeed, the characteristics and performances of a gliding board are determined as a function of its outer geometry, on the one hand, and of its various characteristics of flexural and torsional rigidity. However, in a conventional construction, these two elements are not independent. Indeed, the ends of the boards are generally thin, which makes it difficult for these two ends to be as rigid and solid as would be desirable. In addition, it is known that certain areas of the board, such as those located under the user's feet, are mechanically more biased than others. However, with a core having a homogeneous density, one might have to choose a dense material as a function of the biases in the most biased zones, whereas one could settle with materials having a lesser density in other zones. One is therefore led to increase the weight of the board.

Naturally, in order to avoid this, reinforcements arranged in the most biased zones are generally provided; but positioning these reinforcements requires additional operations and material.

Boards comprising foam cores are also found in the fields of skiing and snowboarding.

The document FR-2.622.810 describes a method for manufacturing ski cores, in which a polyurethane foam block is cut into a parallelepipedic shape, then thermoformed so as to obtain the desired thickness at each point of the ski. According to the method thus described, the final density of the core is thus variable along the ski, and in each point of the core, it is compulsorily conversely proportional to the final thickness of the core at this point.

The object of the invention is therefore to provide a new method for manufacturing a board, which allows simply and cost-effectively manufacturing foam cores varying in density.

For this purpose, the invention proposes a method for the manufacture of a gliding board characterized in that it comprises the following distinct steps, which involve:

- manufacturing a foam core in at least one shaping step by machining;
- proceeding with shaping the core by thermoforming with matter compression of the foam preform;
- covering the core with an outer skin.

The invention also relates to a gliding board comprising at least one foam core covered with an outer skin, characterized in that the foam core has at least one first zone and one second zone, the second zone being both thicker and denser than the first, without material discontinuity between said zones.

Other characteristics and advantages of the invention will be set forth in the detailed description that follows, with reference to the annexed drawings, in which:

- Figures 1, 2, and 3 are schematic top, side, and end views, respectively, of a kitesurfing board;
- Figure 4 is a side view of a rectangular foam cake;
- Figure 5 is a side view of the foam cake of Figure 4 after having undergone a first preforming operation involving matter removal thickness-wise.
- Figures 6, 7, and 8 are schematic side, top, and end views, respectively, of the core of a kitesurf board after having undergone a shaping step by thermoforming with matter compression;
- Figure 9 is an enlarged, partial, and cross-sectional view of the kitesurf board obtained according to the method of the invention;
- Figures 10 and 11 are top and side views of a second example of embodiment of a core preform for a board according to the invention;

- Figure 12 is a cross-sectional view of the core obtained according to the method of the invention, from the foam preform shown in Figures 9 and 10;
- Figure 13 shows a ski core on which densified zones are shown according to the invention;
- Figure 15 is a schematic, partial, and cut away perspective view of a ski core with complex forms, and Figure 14 is a similar view of a core preform that allows obtaining the core of Figure 15 using a method according to the invention;
- Figures 16 and 17 are cross-sectional views along the lines XVI-XVI and XVII-XVII of Figure 15;
- Figures 18 and 20 are top and transverse cross-sectional views, respectively, of a snowboard core obtained according to the invention, and Figure 19 is a transverse cross-sectional view of a machined core preform allowing to obtain said core;
- Figures 21 to 23 are cross-sectional schematic views showing an embodiment of the invention, in which the method allows integrating an insert into a foam core.

Figures 1 to 3 show an example of kitesurf board 10, the outer shapes of which correspond substantially to what is commercially available. The board is essentially planar and thin. However, as shown in the side view in Figure 2, it has a non negligible curvature. The lateral edges 12 of the board are arched and the board also comprises arched end transverse edges 14. Preferably, the board is slightly thicker in its center than in the vicinity of its edges 12, 14. The lower surface 16 of the board, which forms the hull, has, for example, a slightly concave shape, which longitudinally extends in its center, the longitudinal edges of the hull being substantially planar.

Naturally, the board is equipped with accessories such as, on its upper surface, bindings to tighten the user's feet, and on its lower surface, four wings 18 arranged in the vicinity of the four corners of the board. On the upper surface

20, also referred to as the deck, the board comprises bindings 22 in which the user can slide his feet in order to maneuver the board.

Naturally, this example of gliding board is non-limiting, and it could have another geometry or be provided with other accessories, etc.

According to the teachings of the invention, and as shown in Figure 9, the board comprises a foam core 24 that is covered with an outer skin 26, and which has zones varying in density without material discontinuity.

The principle of the invention rests on the manufacture, from a preform 23, of a foam core 24 preferably having a shape close to that of the final board, this shape being acquired prior to the core 24 being covered with the outer skin 26, and this form being obtained by a method having at least one thermoforming step with material compression.

Thus, one can start, for example, from a parallelepipedic initial foam core 21, such as shown in Figure 4. This cake then has an initial length L0, a width l0, and a height H0. In most cases, however, and as a function of the method for producing this initial cake, it has a relatively homogeneous density. Possibly, if the cake 21 is, for example, directly obtained by molding, it can have a surface crust having a higher density, but this crust will be substantially homogeneous over the entire surface of the cake. Preferably, one will use a thermoformable foam, for example, a PVC foam such as those marketed under the tradename "AIREX". Other materials can be used, especially extruded polystyrene foams, and more generally all cellular materials having a synthetic resin basis.

From this rough form 21, one will seek to obtain a preform 23 for the core. Thus, in the case that is shown, a simple operation to shape the cake 21 by machining thickness-wise has been provided. Therefore, the preform 23 of the core schematically shown in Figure 5 is obtained, on which one can notice, for example, that the preform has a reduced thickness H1 in the area of its longitudinal ends. This machining operation remains particularly fast and simple for, over a given width, the thickness of the preform is constant. This machining operation can be carried out in various ways, especially by hot-wire cutting or by planing.

This preform 23 can possibly undergo other shaping operations before the step of thermoforming with material compression.

This thermoforming step according to the invention involves introducing the preform 23 of the core in the mold of a press (not shown), preferably a hot press. The preform 23 will preferably have been heated previously and brought to a temperature close to the foam thermoforming temperature. The mold will preferably have rigid surfaces.

Once in the mold, the preform is subject to a compression force, which causes a deformation of the foam by crushing, at least in certain areas, and due to the fact that this pressure is applied at a temperature that is at least close to the thermoforming temperature, this deformation becomes permanent. Thus, after the cooling and opening of the mold, the foam will have definitively taken the shape of the core 24.

In the example of embodiment shown in Figures 6, 7, and 8, one can see that the initial foam cake 21 had substantially larger longitudinal and transverse dimensions than those of the core 24, such that it is necessary, after the thermoforming operation, to proceed with cutting the core 24 along its contour line C. Alternatively, one can provide for the mold of the press to be provided with sharp edges along this contour line, the cutting operation being then carried out simultaneously with that of thermoforming. One can also provide for the preform 23 to have a contour sufficiently close to that of the core, so that no cutting would be necessary.

In the example shown, the core was made in a press moveable along one direction, in this case along the direction of the thickness of the preform 23 and of the core 24. However, one can envision to use a mold, the lateral sides of which, corresponding, for example, to the longitudinal edges of the preform, would also be transversely moveable, so that the preform would undergo a compression in two directions.

Using a PVC foam having an initial density of 80kg/m^3, this thermoforming operation can be carried out at a temperature of 80°C, at a pressure of 8 bars, for a duration of 222 seconds.

In some cases, especially when certain zones are adapted to undergo a substantial densification ratio, one can provide for the thermoforming step with material compression to be carried out in several gradual sub-steps, these various sub-steps using, for example, different molds, for example.

Thus, each of the various foam core areas will have been subject to a force and a compression amplitude that is essentially dependent upon the initial thickness of the preform in this area and upon the final thickness imposed by the corresponding surfaces of the closed mold. However, the tests have shown that, under the above-mentioned conditions, it was possible to locally reduce the thickness of the foam to less than a quarter of its initial thickness, that is, by multiplying its density by at least a factor of 4, without deterioration of the foam. Conversely, the foam thus densified becomes stronger in flexion and compression. Such advantages are markedly noticeable once a densification rate of about 10 to 20 percent, depending on the foam, has been reached, and are obvious at a densification rate of 100 percent, corresponding to double the initial density of the foam.

As shown in Figure 9, a local reinforcement of the core material can thus be obtained in the area of the edges 12, 14 of the board 10, which will translate into a greater strength of the edges of the boards, which are precisely exposed to impacts.

In the example shown, in which the preform of the core has undergone a preliminary machining step aiming at reducing the thickness of its ends to the thickness H1, which is less than H0, the densification rate of the core in the area of the longitudinal ends of the board will therefore be lower than the densification ratio observed near the longitudinal edges. Thus, flexibility can be easily varied in various zones of the board. However, the entire peripheral area of the core has a higher density than that of the central area.

One must note, however, that the thermoforming step according to the invention may well leave some areas of the core preform completely intact, without any deformation. Likewise, it can also impart on certain areas geometrical deformations that do not lead to any noticeable material

compression. Certain areas can thus be only bent by thermoforming, which, involves almost no material compression, especially for elements having a low thickness.

As shown in Figures 10 to 12, the invention is particularly useful in locally reinforcing areas of the board other than the peripheral area, especially the areas adapted to receive accessories such as the bindings 22 or wings 18.

Thus, one can provide that the preform of the core comprise excess thicknesses (in the compression direction provided for the shaping step) corresponding to the areas of the core in which one wishes to densify the foam. In the example shown, one has chosen to densify the areas of the board that are adapted to receive the bindings 20. Indeed, these areas of the core of the board will have to allow for securely anchoring the bindings, on the one hand, and will have to directly support the pressure forces due to the user's supports. It is therefore particularly advantageous to reinforce them. This is achieved in a particularly simple manner due to the invention. As seen, excess thicknesses 28 are provided in the preform, in the areas to be densified. These excess thicknesses 28 are obtained directly by molding, if the initial foam cake was obtained in this manner, or they are obtained by machining, manually (planing, sanding, etc) or with a piece of equipment (digitally controlled milling machine, etc).

After the material compression thermoforming step according to the invention, the core shown in Figure 12 is indeed reinforced in the predefined areas. This local reinforcement enables the positioning of inserts in the core, which enable the anchoring of the bindings.

The same method of local densification of the core can be used, for example, to create "stiffening beams" that are directly integrated in the core, without material discontinuity. For example, if an increase in the rigidity of the board in torsion is desired, one can provide for the core to comprise diagonal beams, each connecting to two opposite corners of the board. A central longitudinal beam, which is well-known in the field of surfboard manufacturing, can thus be created in the core.

Finally, the material compression thermoforming technique can also be used to create simple, hollow and/or raised decorative designs, for example on the upper surface of the board.

Due to the invention, it is therefore possible to locally densify and reinforce the core, exactly where necessary. Contrary to certain cores of the prior art, in which local reinforcements are integrated into the form of inserts made from a different material than the base material of the core, the technology according to the invention allows preserving a continuity of the core material between the less dense areas and the denser areas. In addition, it is very easy to create a gradual density gradient in order to avoid sudden discontinuity of the density between the less dense areas and the denser areas. This only requires that the height variation along the edge of the excess thickness provided on the preform be gradual (as shown in Figure 11 for the excess thicknesses 28). One thus avoids areas of sudden variation of the core's mechanical characteristics, which are always areas where force constraints are concentrated, and are therefore always weakened.

Naturally, shaping the core by thermoforming allows obtaining at the same time the outer geometrical shapes that are intended for the board, especially its thickness profile, the possible hull shapes, and/or front or rear raised spatula-shaped portions. However, one can also provide for the shape of the core 24 to be corrected after the thermoforming step by means of a complementary operation, for example, shaping by machining, therefore by material removal.

The initial density of the foam core will naturally be selected as a function of the desired final characteristics for the gliding board, especially the desired stiffness and strength. Of course, one will also take into account the weight/volume ratio desired for the board, especially if one wishes to have specific characteristics in terms of floatability. In this context, being able to selectively densify the foam will allow preserving a low foam density in the least biased areas.

In the examples shown, the gliding board comprises only one core. However, for various reasons, the use of a plurality of cores can be envisioned,

for example, two superimposed cores. Within the finished board, these two cores can be separated, for example, with a reinforcement layer such as a sheet of resin-impregnated fiber fabric, a metallic strip, etc. In any case, one can then provide that only one core be shaped according to the invention.

Naturally, once the core is made according to the teachings of the invention, the manufacture of the board can be carried out using the usual methods. All of the usual materials can be used to make the skin adapted to cover the core. This skin can have, for example, a single thermoformed ABS resin sheet, a composite sandwich complex, glass/carbon/Kevlar fiber composites embedded in polyester or epoxy resins. The skin can also include localized reinforcements, such as very high-density foams, cellular materials of the honeycomb type, etc.

As shown in Figure 9, the board can also be provided, along its edges, with a peripheral reinforcement 30 made from plastic material, for example ABS.

It has been noticed with respect to making a kitesurf board that, it could be advantageous to use a metallic reinforcement in the skin of the board. This metallic reinforcement can be, for example, a sheet of aluminum alloy with a thickness of several tenths of millimeters. This metallic sheet, which, for example, covers the upper surface of the board, is embedded in a (preferably thermosetting) resin. In order to reduce the weight thereof, one can provide that it comprises recesses, for example, holes that are regularly distributed over its entire surface.

Using these various materials adapted to form the outer skin can require subjecting the assembly to non negligible temperatures and pressures. Tests have shown that a core made according to the invention could withstand, without any difficulty, a step for manufacturing the skin requiring temperatures on the order of 120°C for durations of about 10 minutes. These conditions thus allow using all the usual materials.

The invention can also apply to boards for snowboarding, to skis in general (in alpine skiing, touring skiing, cross-country skiing, etc), to water skis, and to boards for wakeboarding.

In the following Figures, various embodiments of the invention are shown in the context of other types of gliding boards.

Figure 13 shows an embodiment of the invention used to create a reinforcement of the density of a ski core 24 in its central portion 32 (or platform, the one adapted to receive the binding system), as well as in areas forming "stiffening" 34 in X, which, originating from the center of the ski core, extend in the direction of the front and rear lateral ends. In an alternative embodiment, as with the kitesurf example, one could elect to reinforce the periphery of the core. The core in Figure 13 is easily obtained with the invention, by machining a core preform so that it has excess thicknesses, the shape of which correspond to said zones. The final core can selectively have excess thicknesses in the area of the zones thus densified, or, conversely, a "smooth" upper surface.

Figures 14 to 17 show the embodiment of the invention for obtaining a ski core 24 having a central platform 32 that is raised and densified, as well as, at the front and rear of this platform 32, two semi-cylindrical flanges 36 that extend in parallel to one another along a substantially longitudinal direction on the upper surface of the core. Such a core, schematically and partially shown in Figure 15, can be obtained from a machined preform 23, such as shown in Figure 14. This platform 23 has a very thick central portion 38 and, longitudinally on both sides, front 40 and rear 42 portions having a substantially rectangular section, the height of which corresponds substantially to the height of the flanges 36 of the final core. In this way, after the thermoforming step, the central platform 32 is very dense (Figure 17) and the front 40 and rear 42 portions of the core are not dense in the area of the flanges 36, and are more dense between the flanges 36, as well as on both of their sides, on the lateral edges (Figure 16). Naturally, with another geometry of the machined preform, it could have also been provided that the core be conversely more dense in the area of the flanges 36 than in the adjoining areas.

The invention can also be carried out for making a core having dissymmetrical properties. Figure 18 shows a core 24 for a snowboarding board having a lateral side 44 where the foam density is higher than on the opposite

lateral side 46. Due to the invention, this can be easily obtained by machining a core preform 23 having the profile shown in transverse cross-section in Figure 19, where one side is thicker than the other. After thermoforming, a core is obtained, having, for example, a constant thickness (see Figure 20) which has a widthwise density gradient. In the case of a core of a board for snowboarding, one can naturally also provide to densify the core in the area of the zones adapted for receiving the bindings, as seen with respect to the board for kitesurfing. The lateral dissymmetry described here can, of course, be provided as a longitudinal dissymmetry, or the like.

Generally speaking, the various alternative embodiments, which have just been mentioned can naturally be provided and used regardless of the type of gliding board envisioned, and can generally be combined together.

The embodiments of the casing of these various boards will not be described any further, since a core made according to the invention can be used with most known methods and constructions, especially in the field of skiing and snowboarding (sandwich construction, “cap” construction, “shell” construction, etc.).

In addition, the method according to the invention can advantageously be used for making foam cores provided with inserts.

The principle is schematically described in Figures 21 to 23.

For example, one wishes to completely or partially integrate an insert 48 (wooden or made from plastic, composite material, metal, etc.) into a foam core 24. This insert 48 can, for example, be adapted to form an anchoring reinforcement adapted to receive screws for anchoring a binding system, and it is adapted to be received (at least partially) in a housing 50 having a corresponding shape and arranged in the foam core 24 (see Figure 22). Rather than having the housing 50 made by material removal machining, it is made according to the invention by material compression thermoforming.

The housing can be made in two ways. First, it can be made due to a shape adapted from the thermoforming mold. In this case, the core of Figure 22 is obtained from a preform 23 such as shown in Figure 21. In this case, the

preform, the insert, and the core have very simple geometrical shapes; but making the housing by thermoforming is all the more advantageous as the shapes of the insert (and therefore of the housing 50) are complex.

However, it can be even more advantageous to provide for the insert to be positioned inside the thermoforming mold (for example by being laid flat against the cover of the mold), and for the insert itself to form the housing in which it is to be inserted. This embodiment naturally guarantees a complete adaptation of the housing shape to that of the insert. Thus, the insert is used as a thermoforming tool allowing to form the housing. To this end, it would be advantageous for the insert itself to be heated to the thermoforming temperature or to a near temperature (as long as it withstands such a temperature without losing its mechanical characteristics, since, in this embodiment, it must withstand the force that is necessary for the compression of the core foam). Likewise, it can be envisioned that the surface or surfaces of the insert, which are in contact with the core, be provided with an adhesive, or even a reinforcement made of resin-impregnated fibers.

In both cases, as shown in Figure 23, one thus obtains a precise insert assembly in the core, and at the same time, one proceeds with a densification of the core under the insert.

From all of the examples of embodiment of the invention, it is understood that thermoforming the foam core with material compression allows making the best out of the great flexibility of use of the foams and reinforcing in the same operation the mechanical characteristics of the core where desired, this from a foam cake having a homogeneous density. Providing a step to machine the preform with material removal makes it possible to distribute the quantity of the core with great precision and complete design freedom. This especially allows obtaining, in a same core, areas which are at the same time thick and dense, or thin and not dense, without discontinuity of material. For ski making, for example, it is possible to have a thick and dense central area, which is favorable to a reliable anchoring of the binding system, and ends that are thin and not

dense, and therefore particularly light, allowing to reduce the ski inertia to the rotational movements.